REGIONAL BREWER CALIBRATION CENTRE-EUROPE (RBCC-E)

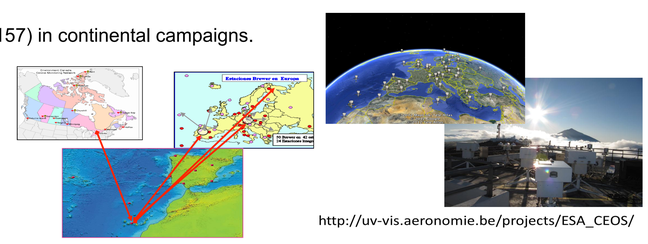
Alberto Redondas, Juan José Rodríguez, Marta Sierra and Virgilio Carreño
Izaña Atmospheric Research Center, AEMET, Santa Cruz de Tenerife, Spain

Contact: aredondasm@aemet.es
www.iberonesia.net

BACKGROUND. In November 2003 the WMO/GAW Regional Brewer Calibration Centre for RA-VI region (RBCC-E) has been established at the Izaña Observatory (IZO), held by the Izaña Atmospheric Research Centre (IARC, Canary Islands, Spain). The IARC is part of the Planning, Strategy and Business Development Direction from the Meteorological State Agency of Spain (AEMET). RBCC-E owns a full calibration and reference-maintenance equipment composed of three Brewer spectrophotometers: a Regional Primary Reference (Brewer 157), a Regional Secondary Reference (Brewer 183) and a Regional Travelling Reference (Brewer 185). IZO is located in a subtropical region (28ºN) on the top of Izaña Mountain (2370 m.a.s.l.) with pristine skies and low ozone variability. This location allows routine absolute calibrations of the references in similar conditions to the MLO (Mauna Loa Observatory). The establishment of the RBCC-E Triad allows implementation of a self-sufficient European Brewer calibration system that respects the world scale but works as an independent GAW infrastructure.

OBJECTIVES

1. Implement a system for routine absolute calibrations of the European Brewer regional reference instruments at Izana, fully compatible with absolute calibrations of the world reference Triad at MLO.
2. Perform periodical calibration campaigns using the Regional Primary Reference B157 (during intercomparisons held at Izaña) and the Regional Travelling Reference B185 spectrophotometer (traceable to B157) in continental campaigns.
3. Perform Regular comparisons of the Regional Brewer Primary Reference B157 with the Regional Dobson Reference D074 to monitor the relationship between both calibration scales in the Region.
4. Study the sources of errors of the absolute calibrations and to determine the accuracy of total ozone measurement achievable by this method due to atmospheric conditions or instrumental characteristics.



http://uv-vis.aeronomie.be/projects/ESA_CEOS/

MAIN ACTIVITIES OF THE RBCC-E DURING THE PERIOD 2011- 2012

1. Absolute calibration transfer
2. Three intercomparison campaigns were organized by the RBCC-E
3. The publication of new absorption coefficients developed by the University of Bremen has been a thorough review of the calculations of ozone for Brewer and Dobson spectrophotometers
4. Technical developments and Training activities

ABSOLUTE CALIBRATION

The IZO Triad is linked to the Environment Canada (EC) Triad by yearly calibrations towards the travelling reference BR 017.Recently because of doubts about the support of the world triad by EC , the WMO SAG Ozone authorizes at the meeting of 2011, that the RBCC-E transfers its own calibration based on Langley at Izaña Station. At the recent Arosa 2012 campaign the RBCC-E transfer his own Langley calibration.

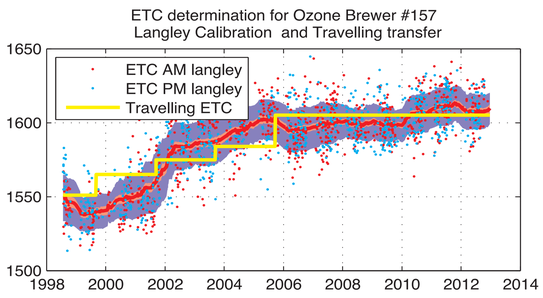


Figure 1: Long term comparison (1998-2012) of the Extraterrestrial constant (ETC) transferred during regular comparisons with the travelling standard Brewer #017 (yellow line) and the ETC obtained by Langley-plots at Izaña for the RBCC-E primary reference Brewer #157. The red line is the monthly smoothed ETC obtained by the Langley. The red area represent the 95% confidence interval of the mean and the blue area one standard deviation.

The comparison of the calibration by Langley with the calibration of the travelling reference (Figure 1) show a long term differences les than +-.5 % (Figure 2). This differences are on the same order than found during calibration campaigns with instruments who are directly calibrated with the WRT.

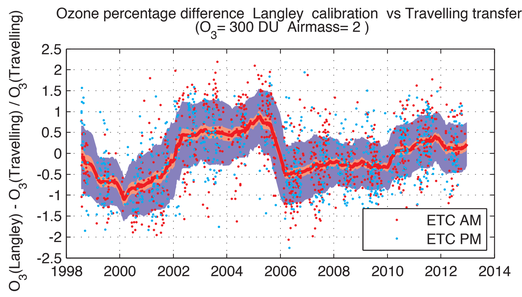


Figure 2: Effect on the Ozone measurement if we use the Langley calibration (Figure 1) vs the Calibration from travelling reference Brewer #017 on the RBCC-E primary reference Brewer #157 (Assuming an ozone total content of 300 DU and airmass 2) . The red line is the monthly smoothed percentage difference. The red area represent the 95% confidence interval of the mean and the blue are the standard deviation.

To assure the calibration of the triad, routinely calibrations are performed on montlyy basis. During the ESA-CAL VAL project We have achieved a long term agreement between the instruments of the triad with a precision of less than 0.25% in ozone.

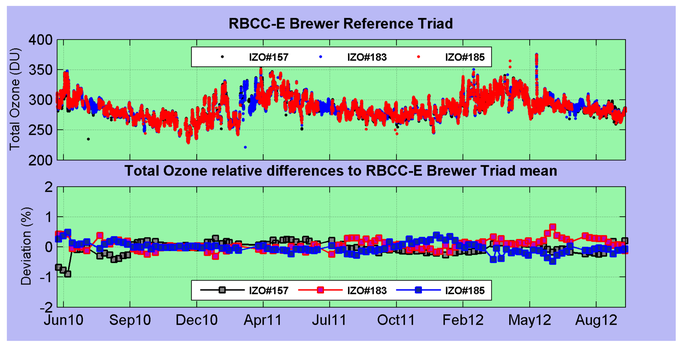


Figure 3: Long term weekly comparison of the RBCC-E triad during the period March 2010 to October 2012. (a) Total Ozone content (DU) (b) and weekly relative percentage ozone differences of each triad instrument with respect to triad ozone mean.

INTERCOMPARISONS

Institution	Name	Brewer	Country
IOS	Martin Stanek, Volodya Savastiouk	#017-MKII	Canada
LKO	René Stübi, Herbert Schill, Werner Siegrist	#040-MKII, #072-MKII, #156-MKIII	Switzerland
AAB	Henri Diemoz	#066-MKII	Italy
URO	Giuseppe R. Casale	#067-MKII	Italy
K&Z	Wim Roeterdink	#158-MKIII	Netherland
WRC	Julian Gröbner, Gregor Huelsen	#163-MKIII	Switzerland
AEMET-IARC	Alberto Redondas, Juan J. Rodriguez, Virgilio Carreño, Marta Sierra	#185-MKIII	Spain

Table 1: Participating instruments at the Arosa 2012 intercomparison campaign

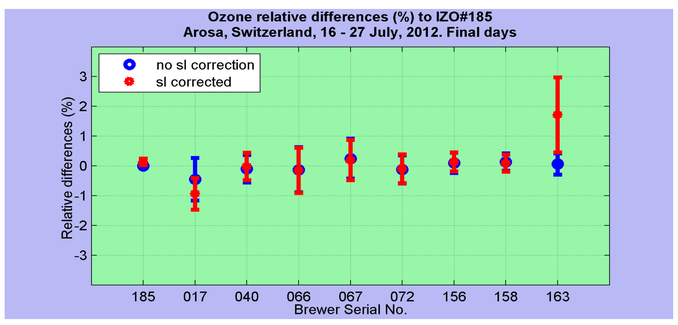


Figure 4: Ozone relative percentage differences of Arosa 2012 participating instruments to RBCC-E traveling standard Brewer #185. Ozone measurements collected during the final period are reprocessed using the final calibration constants.

AROSA LICHTKLIMATISCHES OBSERVATORIUM

IZAÑA ATMOSPHERIC RESEARCH CENTER

Two intercomparisons campaigns were organized by the RBCC-E during the last year (2012), under the auspices of the ESA funded project "***CEOS Intercalibration of Ground-based Spectrometers and Lidar***": the seventh RBCC-E intercomparison campaign held at Arosa (Switzerland, July 16 to 27, 2012) and the absolute calibration campaign held at Izaña (Spain, September 20 to October 12, 2012), both with the participation of the Regional Dobson Calibration Center for Europe (RDCC-E).

Arosa 2012: Nine brewer instruments participated in the campaign. These routine intercomparison campaigns provide the brewer community with the opportunity to assess the European network instruments status. The initial comparison, using the instruments' original calibration constants, shows a very good agreement, with most of the instruments within the 1% ozone relative differences as compared to the reference Brewer #185. After the maintenance and calibration the agreement was very good for all the instruments (within the 0.5% range for the stray light free region).

Izaña 2012: During this campaign, an evaluation of the differences between the Langley Plot methods of both Brewer and Dobson reference instruments was performed and assessed. The comparisons of Brewer from RBCC-E and Dobson 64 from RDCC-E shows an disagreement of about 1.5% in agreement with the different common calibrations performed during the project. There is no significant change on the calibration if we use the Dobson methodology on the Brewer. On the other hand the spread Langley extrapolation on both instruments are related, which confirms that can be due to the atmospheric variability and not instrument performance.

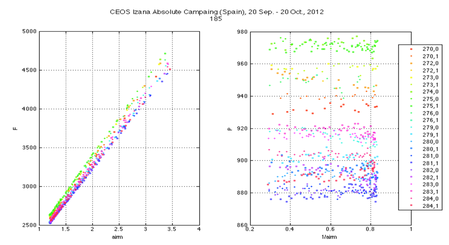


Figure 5: Langley plots for the Brewer 185 during the campaign. We show in the left panel the regression vs. mu and in the right panel the Dobson method P= F-ETC/nu vs. 1/mu

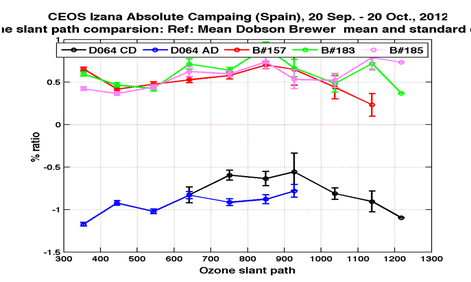


Figure 6: Ozone slant path (right) total ozone Brewer and Dobson t comparison during the campaign. The percentage ration is represented: o3-ref/ref with the reference the mean of the three brewer instruments and the Dobson AD/CD pairs.

STUDY OF THE EFFECT OF NEW OZONE CROSS SECTION (ACSO)

Four different ozone cross sections were evaluated for use with Dobson and Brewer instruments. These are the Bass & Paur "operative" cross sections used by Brewer and Dobson, the quadratic adjustment of Bass & Paur (IGACOQ4), the high resolution cross section of Daumont, Brion & Malicet (DBM), (Daumont et al., 1992), (Brion et al., 1993), (Malicet et al., 1995) and the cross-section data set recently developed by the university of Bremen (UIP, Serdyuchenko et al., 2011, 2012). Whereas on the case of the Dobson the calculated ozone change is of +1% with very little variation depending on which dataset is used on the case of the Brewer the changes are substantial in the case of DMB (-3.2%) and less important for UIP (-0.5%). (All datasets and references available at ACSO website **http://igaco-o3.fmi.fi/ACSO/index.html**)

When we apply these changes to the European Dobson and Brewer reference instrument during the CEOS Izaña 2012 Absolute Calibration Campaign we found that the application of a common Langley calibration and the UIP cross section the differences between Brewer and Dobson vanish where as B&P and DBM have differences of +1.5% and -2% respectively.

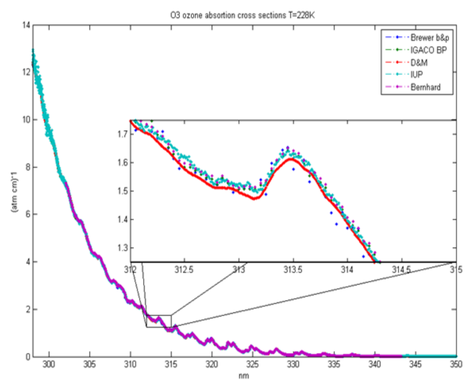


Figure 7: The five ozone cross section data sets at -45ºC used on this work, Bass & Paur (Brewer), Bass &Paur (IGACO4), DBM Daumont, Malicet and Brion (IGACO4) the new set from Bremen university (IUP) and the set of B&P used by Bernhard 2005.

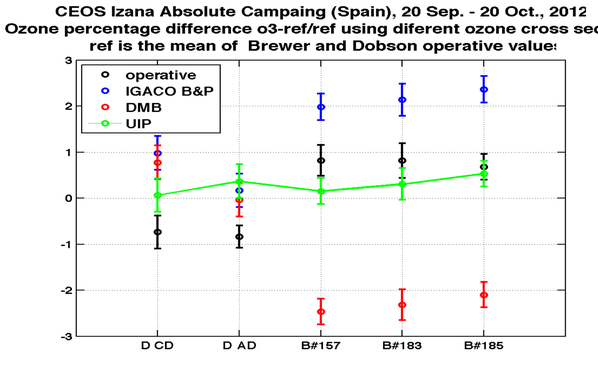


Figure 8: Mean and standard error ozone relative percentage differences. The reference is the mean of Dobson AD and CD pair and IZO triad evaluated with the operational ozone cross section (Bass & Paur). Ozone is calculated using four different cross sections: 1) Operational (Bass & Paur) 2) Bass & Paur at -45C from quadratic coefficients 3) Daumont, Malicet & Brion (DBM) and 4) University of Bremen (UIP).

TECHNICAL DEVELOPMENTS AND TRAINING ACTIVITIES

GAW Calibration Centres are operated by institutions participating in the GAW program able to provide sufficient technical facilities and highly qualified personnel. Main RBCC-E activities in this area during the reporting period have been:

- Calibration of the Brewer from Uruguay. Support for its installation at the Antarctic base and data evaluation through the Iberonesia database/tool (July-October 2012).
- Installation of a double Brewer at the global GAW station of Tamanrasset (Algeria, October 2011) and permanent supervision and counseling of the Brewer operation.
- The straylight effect was characterized during the campaigns and this was used to develop an instrumental model suitable for corrections (Figure 9).
- Testing of new electronic board for Brewer spectrophotometer (March 2012).
- Evaluation of the NO2 measurements with the Brewer MKIV with Dr. H Diemoz (Aosta, Italy) in September 2012 (Figure 10).
- One-week practical course to three expertises of the Korean Meteorological office at the RBCC-E (December 2012).
- New improvements of RBCC-E database 'iberonesia' (www.iberonesia.net /www.iberonesia.com).

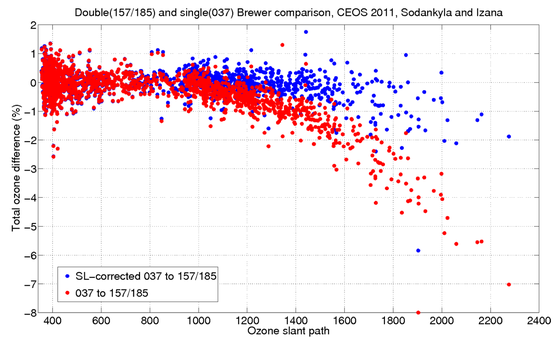


Figure 9: Ratio between the Brewer no.37 and RBCC-E reference Brewer no.157 before (red) and after (Blue) stray light correction as a function of the ozone slant path. The method significantly improves the agreement in high slant paths. From Karppinen T, Redondas A, Garcia R, Lakkala K, McElroy T, Kyrö E. Correcting Stray Light on Single--monochromator Brewer Spectrophotometers. Submitted to Atmosphere-Ocean)

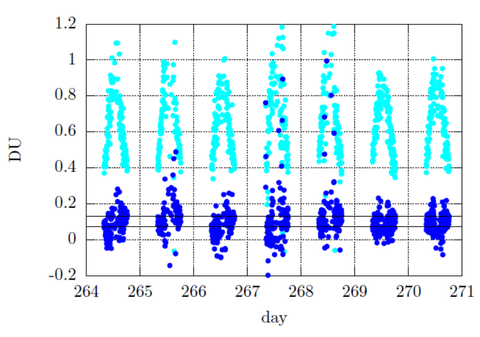


Figure 10:Evaluation of the NO2 measurements with the Brewer MKIV with Dr. H Diemoz (Aosta, Italy) in September 2012. Using the original Brewer algorithm with obsolete ETCs (light blue dots) and the new algorithm with corrected 7ETCs (dark blue dots).